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Relationship Between Proprioception and Dynamic Balance in Knee Osteoarthritis

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Abstract
Background/Aim: *Knee Osteoarthritis (OA) is a highly recognized cause for chronic disability in elders. Patients with knee OA show impairment of dynamic balance and high risk of falls. Poor proprioception was also identified in knee osteoarthritic population and was related to increased risk of falling. The findings of studies conducted to correlate between dynamic balance and proprioception in these patients are conflicting. The aim of this study was to find if there is a relationship between dynamic balance and proprioception (sense of position and sense of movement) in patients with knee OA.*
Subjects and Methods: *Thirty nine female patients with knee Osteoarthritis grade II and III Kellgren and Lawrence (KL) scale, aged from 40 to 65 years old were included in the study. Biodex Balance System (BBS) was used to evaluate dynamic balance and retrieve three outcome measures: Overall stability Index (OSI), Mediolateral Stability Index (MLSI) and Anteroposterior Stability Index (APSI). Proprioception was measured through Biodex system 3 isokinetic dynamometer in which knee joint reposition task and the threshold to detection of passive motion (TTDPM) were used to assess the sense of position and the sense of movement respectively.*
Results: *Pearson correlation coefficient was used. There was nonsignificant correlation between proprioception and dynamic balance ($P > 0.05$).However, there was a significant correlation between the sense of position and sense of movement ($P < 0.05$).*
Conclusion: *There is no relationship between decreased proprioception and impaired dynamic balance in patients with knee OA.*
Key words: *Osteoarthritis –dynamic balance -proprioception.*

Introduction

Osteoarthritis (OA) is the most widely recognized reason for chronic disability in older adults,[1]. In the knees, OA can cause chronic disability among the elderly, limiting them in their routine activities and household chores thus, increasing their risk for falling. [2]

Dynamic balance is essential for independence. Those with knee OA shows impairments in dynamic balance ability and increase risk of falling.[3] It is hypothesized that this reduced dynamic balancing ability may be attributed to neuromuscular changes linked to impairments associated with the disease, and beyond those

changes normally experienced with healthy aging.[4] Neuromuscular deficits seen in those with knee OA which may affect dynamic balance include increased muscle weakness, impaired proprioception, altered postural control, and reduced knee joint range of motion.

It seems that the degenerative process of OA not only causes local degenerative changes in joints and muscles, but also has far greater influences on movement performance and function. An important connection between the disease process and function may be proprioception. Impaired proprioceptive sense has been identified in individuals with knee OA.[5]

Those with knee OA also have greater difficulty with joint repositioning (proprioception) tests than healthy controls [6] and poor proprioception has been associated with an increased risk of experiencing multiple falls.[7]

Although many studies have reported relationships between proprioception and dynamic balance in individuals with knee OA, the results are conflicting.

The detection of factors present in OA that might be associated with falls can aid health care professionals to program a more specific preventive intervention, because the risk of new falls increases after a fall. Thus, this study aimed to find a relationship between proprioception and dynamic balance in individuals with knee OA.

Patients, Materials and Methods

Patients

Thirty nine female patients aged from 40 to 65 years old and diagnosed with knee OA according to KL scale with grade II and III were enrolled in the study. All patients underwent physical examination; their medical history and demographic data were obtained. Patients who had Rheumatoid arthritis, history of lower limb surgeries that may affect their balance, had corticosteroid injection in last 6 months or had neurological condition that affected their balance or movement (i.e. Parkinson's or Multiple sclerosis) and vascular disorders were excluded. Awritten informed consent was obtained from each patient and the study was approved by research ethical committee.This study was conducted at the Balance and isokinetic laboratories in the faculty of Physical Therapy – Cairo University, Egypt.

Material and methods

Dynamic balance testing

BBS was used to assess dynamic balance. It is a multiaxial apparatus that obtains objective measures of postural stability under dynamic perturbation. Unlike force plate systems, the BBS uses a circular platform that freely moves in the anterior–posterior and medial–lateral axes simultaneously.[8]The BBS measures in degrees, the tilt about each axis during dynamic conditions and calculates a medial–lateral stability index (MLSI), anterior–posterior stability index (APSI), and an overall stability index (OSI). These indexes represent fluctuations around a zero point established prior to testing when the platform is stable.[8]For assessing dynamic balance, patients were asked to wear comfortable loose clothes and stepped on device barefoot with no shoes or socks to perform the test. Patients' weight and height were entered manually then the test parameters wherea test duration of 20 seconds and the stability level (7) were chosen. Patients were asked to preserve a centering process by standing on both feet. Then the platform was unlocked and patients were required to maintain the position of feet for the test and try to maintain balance when platform unlocked. Patients performed one trial andif they held the handles due to balance loss, the test would have been restarted.At the end of the testing procedures, the final report included three main outcome measures: OSI, APSI and MLSI.

Proprioception testing

Biodex system 3 isokinetic dynamometer(Biodex Medical Systems, Shirley, New York, USA)was used to assess proprioception (Sense of position and sense of movement). The device consists of a dynamometer, a chair, a control panel and the PC

unit. Isokinetic dynamometer provides an objective, reliable, and safe method with intraclass correlation coefficients (ICC) of 0.99 and provides valid measures in terms of angular position, torque and velocities for testing and training of different muscle groups in the upper and lower extremities as well as the trunk.[9]Two tests were used to assess knee joint proprioception which were knee joint reposition task and the threshold to detection of passive motion (TTDPM) to assess the sense of position and the sense of movement respectively.Steps of measurement were explained for each patient, followed by entering personal data to computer database. Before the testing, each participant performed two trials to get familiarized with the procedure.

For knee joint reposition task, patients were seated on the Biodex isokinetic dynamometer with hips and knees flexed 90° and were blindfolded for the task. The patients' limbs were passively positioned and held for five seconds in one of three target positions (15°, 30°, and 60° of knee flexion). Patient's knees were then returned to 90° and were asked to actively match the position that their limb were held in. Patients completed 2 blocked trials at each of the 3 randomly presented target positions, resulting in a total of 6 trials. The absolute difference between actual leg position and target position, in degrees, for each trial was calculated using the dynamometer, and the mean difference of the six trials was taken.

To perform the second test TTDPM, patients were seated on same device for joint movement sense testing, however for the kinesthetic evaluations, the initial angle was set at 45° of passive knee flexion and the knee was moved to extension with a displacement velocity of 2°/s, which is the minimum speed of displacement produced by the dynamometer and has been used previously for same purpose.[10-11]Patients were instructed to press the dynamometer lock button, as soon as they perceived any movement of the knee joint. The knee angles were recorded when the movements were interrupted by the subjects. Three repetitions were obtained and the mean value of the three final position measurements, subtracted from the initial angle of 45°, was recorded for analyses.

Data analysis

To find out the presence of a relationship between proprioception (sense of position and sense of movement) and dynamic balance Pearson correlation coefficient, *r*was used. Level of significance was set at $p < 0.05$. Statistical testing was performed usingStatistical Package for Social Sciences (SPSS) computer software version 21. All tests are two tailed.

Results

Thirty nine female patients participated in the study. The mean age of the patients was 54.03 ± 6.318 years. Eighteen patients (46.15%) had their right knees involved and 21 patients (53.85%) had their left knee involved. The radiological stage was stage 2 in 22 (56.41%) and stage 3 in 17 (43.59%). The mean BMI was 36.323 ± 3.98. The mean score of Visual Analogue Scale VAS was 5.79 ± 1.031. (Table 1)

Table 1. Descriptive data

	N	Minimum	Maximum	Mean	Std. Deviation
Age	39	42	65	54.03	6.318
BMI	39	28.3	45.3	36.323	3.9805
VAS	39	4	7	5.79	1.031

The mean OSI obtained using BBS was 4.936 ± 2.3509. The mean MLSI was 3.233 ± 1.9876. The mean APSI was 3.679 ± 1.8217. (Table 2)

In proprioceptive measures, the mean angular error of joint reposition angles was 7.304° ± 2.2926°. The mean angular error of TTDPM angles was 7.159° ± 7.3531°. (Table 2)

Table 2. Summary of proprioception and dynamic balance results

	N	Minimum	Maximum	Mean	Std. Deviation
OSI	39	1.2	10.8	4.936	2.3509
MLSI	39	1.1	10.6	3.233	1.9876
APSI	39	.7	8.4	3.679	1.8217
Joint reposition	39	3.0	13.3	7.304	2.2926
TTDPM	39	1.0	34.0	7.159	7.3531

Table 3 presents the correlation between the two proprioceptive measures (Joint reposition and TTDPM) and the three measures of dynamic balance (OSI, MLSI and APSI). There was no correlation between proprioception and dynamic balance, but there was a weak relation between joint reposition (sense of position) and TTDPM (sense of movement).

Table 3. Intercorrelation (*r*) between proprioception and dynamic balance

	OSI	MLSI	APSI	Joint reposition	TTDPM
OSI	1				
MLSI	.821	1			
APSI	.792	.328	1		
Joint reposition	.027	.000	.095	1	
TTDPM	-.087-	-.056-	-.079-	.412	1

Discussion

This study aimed to find if there is a relationship between proprioception and dynamic balance in patients with knee OA. The lack of correlation between proprioception and dynamic balance agrees with a study by Takacs et al. [12]They identified potential neuromuscular factors associated with dynamic balance inindividuals with knee OA. Despite the importance ofproprioception as a sensory system used to maintain postural control, it was notassociated with dynamic balance (r = - 0.06).

Dynamic balance is more complex function than static balance due to the fact that more inputs are needed from more receptors of different tissues. Duman et al. [13] conducted a study to assess the impact of proprioceptive exercises on balance and proprioception in knee osteoarthritic patients obtained only significant improvements in static balance but not in dynamic balance. They explained their finding by highlighting the fact that dynamic balance needs more effective contribution and efficient coordination of intracapsular and extracapsular structures.

Given the essential role of proprioception in coordination and refining motor activity, a link between proprioception and dynamic balance was expected, however in this study population, no relative relations were found. The lack of correlation may be because tasks on BBS allow visual input, thus reducing the reliance on proprioception. Moreover, the proprioceptive tasks used in this study were non-weight-bearing tests, while tasks on the BBS are weight bearing.

Relatively low number of patients might be a limitation to our study. Besides, the study was only on female patients and their radiological stages were 2 or 3 and thus the resultsof the study can only be generalized to this sub-group of the overall knee OA population, and not to those with other stages of knee OA.

In conclusion, there is nonsignificant correlation between proprioception and dynamic balance in patient with knee OA. Our recommendation for future studies to be directed to other neuromuscular elements that could have been related to poor dynamic balance in this population.

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